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MINISTRY OF INDUSTRY, COMMERCE AND TRADES

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No. BO95 A 000469

It is declared that the attached copy is a true copy of the original documents filed with the above-specified patent application, the data of which are indicated in the attached filing record.

Rome, 06 NOVEMBER 1996

THE DIRECTOR OF THE DIVISION

(Dr. Maria Luisa FOCA')

To the MINISTRY FOR INDUSTRY, COMMERCE AND TRADES **FORM A**
CENTRAL PATENT OFFICE - ROME
APPLICATION FOR PATENT FOR INDUSTRIAL INVENTION, FILING OF RESERVE, ANTICIPATED PUBLIC ACCESS

A. APPLICANT(S)

1) Name: MARPOSS SOCIETA' PER AZIONI — legal status: SP
Residence: BENTIVOGLIO BOLOGNA — identification code: 00316390376
2) Name:
Residence: — identification code:

B. APPLICANT'S AGENT BEFORE THE U.C.B (Central Patent Office)
family name, name: /// — fiscal code No.:
name of agent's office: ///
street: — No. — city: — postal code: — prov:

C. DOMICILE OF CHOICE MARPOSS SOCIETA' PER AZIONI
street: SALICETO — No. 13 — city: BENTIVOGLIO — postal code: 40010 — prov: BO

D. TITLE suggested class (sect./cl./subcl): G01B — group/subgroup: /
"APPARATUS FOR CHECKING THE DIAMETER OF CRANKPINS ROTATING WITH AN ORBITAL MOTION"

ANTICIPATED PUBLIC ACCESS: YES — NO — IF REQUESTED: DATE — / / — RECORD FILE No

E. APPOINTED INVENTORS family name, name

1) DALL'AGLIO CARLO
2) CIPRIANI RICCARDO
3)
4)

F. PRIORITY

	country or organization	type of priority	appln. No.	filing date	encl S/R
1)					
2)					

RESOLUTION OF RESERVE: date — rec. file No.

G. QUALIFIED DEPOSITARY INSTITUTION FOR THE DEPOSIT OF CULTURE SAMPLES FOR MICROBIOLOGIC PROCESSINGS, name

H. SPECIAL NOTES

ENCLOSED DOCUMENTS

	No. copies		
Doc. 1)	2	PROV	No. pages 19 abstract with main drw, descrip. and claims (mandatory 1 copy).
Doc. 2)	2	PROV	No. sheets 06 drawing (if specified in the description, mandatory 1 copy).....
Doc. 3)		RES	power of attorney or general authorization.....
Doc. 4)	1	RES	designation of inventor.....
Doc. 5)		RES	priority documents with Italian translation.....
Doc. 6)		RES	authorization or assignment.....
Doc. 7)			full name of applicant

RESOLUTION OF RESERVE: date — rec. file No.
comparison single priority

8) receipts of payment, lire: five hundred and sixty-five thousand lire dt.03.10.1995 — mandatory
9) revenue stamps for the Letters Patent for lire: — mandatory

FORM FILLED IN ON 03 - 10 - 1995 — SIGNATURE(S) OF APPLICANT(S)
CONTINUATION SHEET YES/NO: NO
CERTIFIED COPY REQUESTED YES/NO: YES

PROVINCIAL OFFICE FOR INDUSTRY, COMMERCE AND TRADES OF BOLOGNA — code 37

FILING RECORD APPLICATION No. BO95A 000469 — Register A

In the year nineteen NINETY-FIVE on the THIRD day of the month of OCTOBER the above mentioned applicant(s) has(have) handed over to me the present application, consisting of 00 additional sheets for the grant of the above indicated patent application.

I. NOTES OF THE DRAWING UP OFFICER NONE

THE DEPOSITOR
Signed Fernando Piccinini

THE DRAWING UP OFFICER

M 19 07 95 PROSPETTA

ABSTRACT AND MAIN DRAWING, DESCRIPTION AND CLAIM

APPLICATION NUMBER	BO95A 000469	REGISTER B	FILING DATE	03 / 10 / 1995
PATENT NUMBER			GRANT DATE	/ /

D. TITLE

"APPARATUS FOR CHECKING THE DIAMETER OF CRANKPINS ROTATING WITH AN ORBITAL MOTION"

L. ABSTRACT

An apparatus for checking the diameter of crankpins (18) of a crankshaft (34) in the course of the machining in a grinding machine comprises a first arm (9) rotating with respect to a support (5) arranged on the grinding-wheel slide (1) of the grinding machine, a second arm (12) rotating with respect to the first, a reference device (20) carried by the second arm and a measuring device (16,17,40-45) associated with the reference device.
A guide device (21), fixed to the reference device (20), enables the apparatus to engage a crankpin, in the course of the orbital motion of the crankpin, and limits the displacements of the first arm and those of the second arm when a control device (28-30) displaces the apparatus to a rest position.

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M. DRAWING

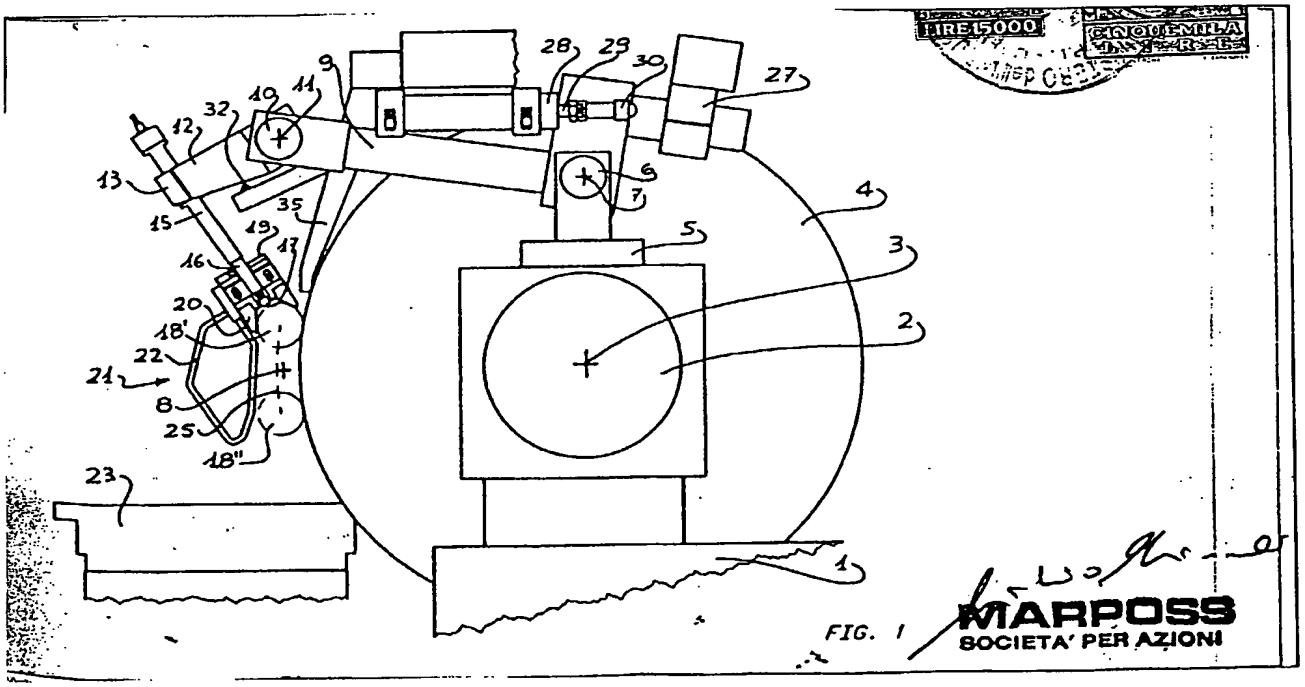

FIG. 1

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Description of the industrial invention titled:

«APPARATUS FOR CHECKING THE DIAMETER OF CRANKPINS ROTATING WITH AN ORBITAL MOTION», in the name of: MARPOSS Società per Azioni, of Italian nationality, with head office in 40010 Bentivoglio (BO), via Saliceto 13.

Appointed inventors: Carlo Dall'Aglio, Riccardo Cipriani.

Filed on: 3rd October 1995.

TEXT OF THE DESCRIPTION

The present invention relates to an apparatus for checking the diameter of crankpins rotating with an orbital motion about a geometrical axis, in the course of the machining in a numerical control grinding machine including a worktable, defining said geometrical axis, and a grinding-wheel slide with a reference device for cooperating with the crankpin to be checked, a measuring device, movable with the reference device, and a support device for supporting the reference device and the measuring device, the support device having a support element, a first coupling element coupled to the support element so as to rotate about a first axis of rotation parallel to said geometrical axis, and a second coupling element carrying the reference device and coupled, in a movable way, to the first coupling element.

US-A-4637144 discloses an apparatus for checking the diameter of crankpins orbiting about a geometrical axis, in the course of the machining in a grinding machine. The apparatus is supported by a support fixed to the worktable of the grinding machine, or by a support affixed to the bed of the grinding machine, or

by a longitudital slide arranged on the worktable.

The apparatus comprises a reference device, Vee-shaped or of another type, for cooperating with the crankpin to be checked, a measuring head fixed to the reference device and provided with two movable arms carrying feelers for contacting diametrically opposite points of the crankpin, a cylinder and piston device, and a coupling device between the cylinder and the support of the apparatus. The reference device is supported by the piston rod and thus is movable along the geometric axis of the cylinder. Moreover, the reference device can rotate, with the cylinder, about an axis of rotation defined by the coupling device and parallel to the geometric axis whereabout the crankpin rotates. The cylinder and piston device comprises a spring, that acts on the piston so as to urge the reference device towards the crankpin to be checked, and a hydraulic or pneumatically actuated device for displacing the piston towards a rest position, in opposition to the force of the spring. In the course of the checking operation, the apparatus is located, with respect to the workpiece, substantially at the opposite side with respect to the one where the grinding wheel is located.

The apparatus and its applications in a grinding machine, described in the formerly mentioned patent, are subject to some inconveniences like considerable layout dimensions, in particular in a transversal direction, high forces of inertia, the impossibility of displacing in an automatic way the reference device from the rest position to the measuring position while the piece (crankshaft) is rotating. These inconveniences are due to both the structure of the apparatus and its application in the machine. All the applications described in the patent involve, in the course of the measurement

taking, that the reference device describes a trajectory basically corresponding to the orbital motion of the crankpin.

U.S. patent No. US-A-4351115 discloses a machine for the dimensional checking of a crankshaft, comprising devices for checking the crankpins in the course of their orbital motion about the main geometrical axis of the crankshaft. Each of these checking devices comprises a guide and reference device, supported by the machine frame, by means of two arms, rotating reciprocally and with respect to the frame, about two axes of rotation parallel to the geometrical axis of the orbital motion. This machine and its associated checking devices are not suitable for checking during the machining operation, among other things owing to the fact that the guide and reference devices describe trajectories that essentially correspond to the orbital motion of the associated crankpin, the speed of the orbital motion is considerably lower with respect to that occurring in the course of the machining in a crankpin grinding machine and the displacement of the checking devices from a rest position to an operating condition occurs when the crankshaft is not rotating.

U.S. patent No. US-A-3386178 discloses an apparatus, for checking the diameter of cylindrical workpieces, rotating about their geometrical axis, in the course of the machining in a grinding machine. The apparatus comprises two arms, rotating reciprocally and with respect to the grinding-wheel slide. One of the arms supports two reference elements or fixed (with respect to the arm) feelers for contacting the surface of the rotating workpiece and a movable stem, with a feeler for contacting the workpiece and an opposite end for cooperating with the movable element of a clock comparator. The apparatus is manually displaced from a rest position to a measuring condition, and vice versa. The

grinding machine cannot machine workpieces rotating with an orbital motion, nor is the measuring apparatus suitable for a similar type of application.

Object of the present invention is to provide an apparatus for the metrological checking of crankpins rotating with an orbital motion, in the course of a grinding operation, or in a similar one, that can provide good metrological performance, high reliability and small forces of inertia.

This problem is solved by a measuring apparatus of the hereinbefore mentioned type, wherein the second coupling element is coupled to the first coupling element in such a way as to rotate with respect to it about a further axis of rotation parallel to said geometrical axis, the support element is fixed to the grinding-wheel slide and there are foreseen a guide device, associated with the reference device, for guiding the arrangement of the reference device on the crankpin in the course of the orbital motion and a control device for enabling the apparatus to displace in an automatic way from a rest position to a checking condition, and vice versa.

Preferably, in the rest position, the reference device is arranged substantially above those positions that, in the grinding machine, are assumed by the geometrical axis of the crankpin to be checked and in the course of the displacement towards the operating condition it enters into engagement with the crankpin, guided by the guide device, describing a trajectory with a prevailing vertical component.

Preferably, the reference device is substantially a Vee-shaped device.

Preferably, the guide device defines a shaped guiding surface that is aligned with a surface of the reference device.

According to another characteristic, the control device can be advantageously

achieved by means of a double-acting cylinder, for example of the hydraulic type.

According to a further characteristic, the apparatus is made so that, in the operating condition, the reference device rests on the crankpin substantially owing to the forces of gravity, the values of which are appropriately predetermined by a suitable arrangement and entity of the weights of the component parts.

Still further aspects of the invention regard, among other things, manufacturing features for enabling the checking of the diameter of the crankpins while avoiding any interferences with the lubrication holes present in the crankpins and for checking crankshafts with even considerably different nominal dimensions, and safety devices for preventing any collisions or unwanted and/or dangerous motions.

The characteristics of the apparatus and of its application in the grinding machine enable to combine remarkable functionality with relatively low costs and to obtain an arrangement of the apparatus that facilitates the loading and the unloading of the crankshafts and limits the layout dimensions in the areas surrounding the more critical elements of the grinding machine and the accessory devices, like the workpiece loading/unloading devices.

The invention is now described in more detail with reference to the enclosed drawings, showing a preferred embodiment by way of illustration and not of limitation. In said drawings:

figure 1 is a lateral view of a measuring apparatus mounted on the grinding-wheel slide of a grinding machine for crankshafts, in the highest position that the apparatus reaches during the grinding of a crankpin rotating

with an orbital motion about the main axis of the crankshaft;

figure 2 is a similar view as that of figure 1, wherein the apparatus is in the lowest possible position it reaches in the course of the grinding of the crankpin;

figure 3 is a lateral view of the apparatus shown in figures 1 and 2 under a condition whereby the grinding machine numerical control has commanded a withdrawal of the grinding wheel for emergency reasons;

figure 4 is a lateral view showing the apparatus of figures 1-3 in the rest position;

figure 5 is a partial front view of the apparatus mounted on the grinding-wheel slide of the grinding machine;

figure 6 shows a detail of the measuring device of the apparatus for the comparative measurement of the diameter of a crankpin so as to avoid interferences with the lubrication hole in the crankpin; and

figure 7 is a partially cross-sectional view of the measuring system of the apparatus.

With reference to figure 1, the grinding-wheel slide **1** of a computer numerical control ("CNC") grinding machine for grinding crankshafts supports a spindle **2** that defines the axis of rotation **3** of grinding wheel **4**. Above spindle **2** the grinding-wheel slide **1** carries a support element **5** that, by means of a rotation pin **6**, with preloaded bearings -not shown-, defining a first axis of rotation **7** parallel to the axis of rotation **3** of grinding wheel **4** and to the axis of rotation **8** of the crankshaft, supports a first rotating, coupling, element **9**. The axis of rotation **7** substantially lies in a vertical plane wherein the axis of rotation **3** of grinding wheel **4** lies, above the axis of rotation **3** of grinding wheel **4** and below

the upper periphery of the grinding wheel. In turn, coupling element **9**, by means of a rotation pin **10**, with preloaded bearings -not shown-, defining a second axis of rotation **11** parallel to the axis of rotation **3** of grinding wheel **4** and to the axis of rotation **8** of the crankshaft, supports a second rotating, coupling element **12**. At the free end of the coupling element **12** there is coupled, fixedly or - as shown in the figures - in an adjustable way, by means of a tie coupling **13** with an associated locking/unlocking knob, a tubular guide casing **15** wherein there can axially translate a transmission rod **16** carrying a feeler **17** for contacting the surface of the crankpin **18** to be checked. The displacements of rod **16** are detected by a measuring device, as hereinafter disclosed. At the lower end of the tubular guide casing **15** there is fixed a support block **19** supporting a reference device **20**, Vee-shaped, adapted for engaging the surface of the crankpin **18** to be checked, by virtue of the rotations allowed by pins **6** and **10**. The transmission rod **16** is movable along the bisecting line of the Vee-shaped reference device **20**.

The support block **19** further supports a guide device **21**, that, according to the following more detailed description, serves to guide the reference device **20** to engage crankpin **18** and maintain contact with the crankpin while the reference device **20** moves away from the crankpin, for limiting the rotation of the first **9** and of the second **12** coupling elements about the axes of rotation **7**, **11** defined by pins **6** and **10**. The guide device **21** consists of a metal rod **22** suitably bent in order to have a guide portion that can cooperate with crankpin **18**.

The crankshaft to be checked is positioned on the worktable **23**, between a spindle and a tailstock, not shown, that define the axis of rotation **8**, coincident

with the main geometrical axis of the crankshaft. As a consequence, crankpin **18** performs an orbital motion about axis **8**. Reference number **18'** indicates the upper position that the crankpin reaches, whereas reference number **18"** indicates the crankpin lower position. Figures 1 and 2 show the positions of the measuring apparatus when the crankpin reaches the upper position **18'** and the lower one **18"**, respectively. Even though crankpin **18** rotates eccentrically about axis **8**, by describing the trajectory indicated by reference number **24**, the trajectory of the pin with respect to the grinding-wheel slide **1** can be represented, substantially, by an arc shown with a dashed line and indicated by reference number **25**. Thus, reference device **20** describes a similar trajectory, with a reciprocating motion from up to down and vice versa and at a frequency - of some tens of revolutions per minute- equal to that of the orbital motion of crankpin **18**. This is due to the fact that the checking apparatus is carried by the grinding-wheel slide **1** that, in modern numerical control grinding machines, machines the crankpins, while they rotate in an orbital motion, by "tracking" the pins so as to keep the grinding wheel in contact with the surface to be ground. Obviously, there is added, to the transversal "tracking" motion, a feed motion for the stock removal. Thus, it is understood that the displacements of the elements forming the checking apparatus involve relatively small forces of inertia, to the advantage of the metrological performance, limited wear and reliability of the apparatus.

As known, modern grinding machines are equipped with a plurality of sensors for detecting various parameters and information, on the ground of which the numerical control of the machine suitably operates. In the event of an emergency, the numerical control can control the grinding wheel to immediately

withdraw from the workpiece. Figure 3 shows the position of the checking apparatus further to the withdrawal of the grinding-wheel slide **1** for emergency reasons. It is understood that in the course of the emergency withdrawal reference device **20** disengages from crankpin **18** and the latter enters into contact with the guide device **21**, remaining in contact with it even at the end of the withdrawal of grinding-wheel slide **1**. In this way the rotations of the coupling elements **9** and **12** about the axes of rotation **7** and **11** are limited and the checking apparatus is prevented from undertaking dangerous positions.

The checking apparatus comprises a counterweight **27**, coupled to element **9**, in such a way that it is prevalently arranged at the opposite side of the latter with respect to pin **6**, and a control device comprising a double-acting cylinder **28**, for example of the hydraulic type. Cylinder **28** is supported by grinding-wheel slide **1** and comprises a rod **29**, coupled to the piston of the cylinder, carrying at the free end a cap **30**. When cylinder **28** is activated for displacing the piston and the rod **29** towards the right (with reference to figure 4), cap **30** contacts an abutment fixed to counterweight **27** and causes the displacement of the checking apparatus in the rest position shown in figure 4, according to which reference device **20** is arranged above the geometrical axis **8** and the orbital trajectory **24** of the crankpin **18**, with the bisecting line of the Vee substantially arranged in a vertical direction. During this displacement, an abutting surface, fixed to the coupling element **12**, contacts a positive stop element **32**, fixed to the coupling element **9**, thus defining a minimum value of the angle formed between the two coupling elements **9** and **12**, for the purpose of both preventing interferences with devices of the grinding machine and defining a rest position for enabling the displacing of the apparatus to the

checking position to occur in the best possible way. The retraction of the checking apparatus to the rest position is normally controlled by the grinding machine numerical control when, on the ground of the measuring signal of the checking apparatus, it is detected that crankpin **18** has reached the required (diametral) dimension. Thereafter, the machining of other parts of the crankshaft takes place, or -in the event the machining of the crankshaft has been completed- the piece is unloaded, manually or automatically, and a new piece is loaded on worktable **23**.

When a new crankpin has to be machined, it is brought in front of grinding wheel **4**, usually by displacing the worktable **23** (in the event of a grinding machine with a single grinding wheel), and the checking apparatus moves to the measuring position. This occurs by controlling, by means of the grinding machine numerical control, cylinder **28** so that rod **29** is retracted. Thus, cap **30** disengages from the abutment of counterweight **27** and, through rotations of the coupling elements **9**, **12**, at first only about the axis of rotation **6** and thereafter also about the axis of rotation **11**, due to the specific weight of the components of the checking apparatus, support block **19** approaches, by describing a trajectory with a mainly vertical component, crankpin **18**, that in the meanwhile moves according to its orbital trajectory **24**. Depending on the instantaneous position of crankpin **18**, the initial contact can occur by means of the guide device **21** or directly by means of the reference device **20**. In any case, the correct cooperation between crankpin **18** and reference device **20** is rapidly achieved. This cooperation is maintained in the course of the checking phase by virtue of the displacements of the coupling elements **9**, **12**, caused by the force of gravity and by the thrust of crankpin **18**, in opposition to the force of

gravity of the elements of the checking apparatus. The structure of the apparatus is such that each of the sides of the Vee of the reference device **20** applies to crankpin **18** a force, due to gravity, of the order of magnitude of the kilogram.

The coupling elements **9** and **12** are basically linear arms with geometric axes lying in transversal planes with respect to the axis of rotation **8** of the crankshaft and to the axis of rotation **3** of grinding wheel **4**. However, as shown in figure 5, wherein there is also shown a crankshaft **34**, in order to avoid any interferences with elements and devices of the grinding machine, in particular with tube **35**, not shown in figure 5, that directs, by means of a nozzle, coolant towards the surface being machined, the coupling elements **9** and **12** comprise portions **36** and **37** extending in a longitudinal direction and portions offset in different transversal planes.

Figures 6 and 7 show some details of the measuring device of the apparatus. In figure 6 there is shown a crankpin **18** featuring in the central part, as usual, a lubrication hole **38**. Whereas, in order to avoid any interferences and provide the most suitable reciprocal position between the Vee-shaped reference device **20** and the surface of pin **18**, the tubular guide casing **15** is symmetrically arranged with respect to the intermediate cross-section of pin **18**, in order to avoid any interferences with the lubrication hole **38**, feeler **17** is off-set with respect to the intermediate section of pin **18**, by means of a transversal portion **40** of the transmission rod **16**.

The axial displacements of the transmission rod **16** with respect to a reference position are detected by means of a measurement transducer, fixed to the tubular casing **15**, for example a "cartridge" head **41** with a feeler **42** contacting

an abutting surface formed in a second transversal portion **43** of the transmission rod **16**. In this way, feeler **17** and measuring head **41** along with feeler **42** are kept aligned along a measurement axis. As shown in figure 7, too, the axial displacement of the transmission rod **16** is guided by two bushings **44** and **45**, arranged between casing **15** and rod **16**. A metal bellows **46**, that is stiff with respect to torsional forces, and has its ends fixed to rod **16** and to casing **15**, respectively, accomplishes the dual function of preventing rod **16** from rotating with respect to casing **15** (thus preventing feeler **17** from undertaking improper positions) and sealing the lower end of casing **15**, whereto the coolant delivered by the nozzle of tube **35**, is directed.

The support block **19** is secured to the guide casing **15** by means of screws **50** passing through slots **51** and supports the reference device **20**, consisting of two elements **52**, **53** with sloping surfaces, whereto there are secured two bars **54**, **55**. In the area **57**, the guide tubular casing **15** is secured to the free end of the coupling element **12**, for example, as hereinbefore mentioned, by means of a tie coupling **13**, not shown in figure 7. The tie coupling **13** enables rough axial adjustments, in the direction of the bisecting line of the Vee defined by bars **54**, **55**, in order to ensure that the two bars **54**, **55** and feeler **17** contact crankpin **18**. The rest position of feeler **17** can be adjusted by means of screws **50** and slots **51**.

A reference device **20** and the associated guide device **21**, not shown in figure 7, cover a predetermined measuring range. In order to change the measuring range, support block **19** is replaced with another block **19** carrying the appropriate reference device **20** and guide device **21**.

There is also foreseen, as schematically shown in figure 5, a proximity sensor

60 adapted for detecting the presence of the crankshaft 34 in the machining position. Sensor 60 is connected to the computer numerical control 61 of the grinding machine. When there is no signal monitoring the presence of a workpiece, the numerical control 61 prevents the retraction of rod 29 of cylinder 28 and thus the checking apparatus cannot displace from the rest position.

There are other proximity sensors 62 and 63, shown in figures 2 and 4, also connected to the computer numerical control 61, for detecting, depending on the position of cap 30, the rest position (figure 4) and the measuring condition (figure 2) of the apparatus, respectively.

It is possible to equip the checking apparatus with further feelers, associated transmission rods and measurement transducers for detecting further diameters and other dimensions and/or geometrical or shape characteristics of the crankpin being machined. The Vee-shaped reference device 20 can be replaced with reference devices of a different type.

It is obvious that in a multiwheel grinding machine simultaneously machining a plurality of crankpins there can be foreseen just as many checking apparatuses.

CLAIMS

1. Apparatus for checking the diameter of crankpins (18) rotating with an orbital motion about a geometrical axis (8), in the course of the machining in a numerical control grinding machine including a worktable (23), defining said geometrical axis, and a grinding-wheel slide (1), movable in a transversal direction, with a reference device (20) for cooperating with the crankpin to be checked, a measuring device (16, 17, 40-45) movable with the reference device, and a support device for supporting the reference device and the measuring device, the support device having a support element (5), a first

coupling element (9) coupled to the support element so as to rotate about a first axis of rotation (7) parallel to said geometrical axis (8), and a second coupling element (12) carrying the reference device (20) and coupled, in a movable way, to the first coupling element (9), characterized in that the second coupling element (12) is coupled to the first coupling element (9) in such a way as to rotate with respect to it about a further axis of rotation (11) parallel to said geometrical axis (8), the support element (5) is fixed to the grinding-wheel slide (1), and the apparatus comprises a guide device (21) associated with the reference device (20) for guiding the arrangement of the reference device on the crankpin (18) in the course of said orbital motion, and a control device (28-30) for enabling the apparatus to displace in an automatic way from a rest position to a checking condition, and vice versa.

2. An apparatus according to claim 1, wherein, in said rest position, the reference device (20) is arranged substantially above said geometrical axis (8) and, in the displacement from the rest position to the checking condition, describes a trajectory (25) with a prevailing vertical component.

3. An apparatus according to claim 1 or claim 2, wherein said axis of rotation (7) of the first coupling element (9) substantially lies in a vertical plane wherein the axis of rotation (3) of the grinding wheel (4) lies.

4. An apparatus according to claim 3, wherein said axis of rotation (7) of the first coupling element (9) lies above the axis of rotation (3) of the grinding wheel (4) and below the upper periphery of the grinding wheel.

5. An apparatus according to one of claims 1 to 4, wherein said guide device (21) has a shaped guiding surface for guiding the reference device (20) to engage the crankpin to be checked (18) in the course of the displacement

towards said checking condition and for maintaining contact with the crankpin while the reference device displaces towards said rest position, for limiting the rotation of the first (**9**) and of the second (**12**) coupling elements about said axes of rotation (**7**) and further axis of rotation (**11**).

6. An apparatus according to claim 5, wherein said guide device (**21**) is made by a bent metal rod (**22**).

7. An apparatus according to one of claims 1 to 6, wherein said reference device (**20**) is substantially of a Vee-shaped type.

8. An apparatus according to claim 7, wherein said reference device (**20**) is adjustable with respect to the second coupling element (**12**) in the direction of the bisecting line of said Vee.

9. An apparatus according to one of claims 5 and 6 and one of claims 7 and 8, wherein said reference device (**20**) and guide device (**21**) can be replaced in order to allow variations of the measurement range of the diameters of the crankpins (**18**).

10. An apparatus according to one of claims 1 to 9, comprising a counterweight (**27**) coupled to said first coupling element (**9**), the reference device (**20**) being adapted for maintaining contact with the crankpin to be checked (**18**), substantially owing to the forces of gravity.

11. An apparatus according to claim 10, wherein said control device comprises a movable element (**29,30**) for cooperating with one of said first coupling element (**9**) and counterweight (**27**) for bringing and keeping the apparatus in the rest position.

12. An apparatus according to claim 11, wherein said control device comprises a double-acting cylinder (**28**).

13. An apparatus according to one of claims 1 to 12, comprising a detecting device (**60**) for detecting the presence of the workpiece to be checked (**34**) in the checking position, the control device (**28-30**) being controlled by the detecting device for preventing the displacement of the apparatus from the rest position when no workpiece is in the checking position.

14. An apparatus according to claim 8, wherein in said rest position the bisecting line of said Vee is substantially arranged in a vertical position.

15. An apparatus according to claims 10 and 14, wherein the coupling between the second coupling element (**12**) and the first coupling element (**9**) comprises a limiting element (**32**) for limiting the rotational displacements of the second coupling element with respect to the first coupling element.

16. An apparatus according to one of claims 1 to 15, wherein at least one of said first (**9**) and second (**12**) coupling elements comprises substantially linear off-set portions (**36,37**), for avoiding interference with elements of the grinding machine.

17. An apparatus according to one of claims 1 to 16, wherein said measuring device (**16,17,40-45**) comprises a guide casing (**15**) fixed to the second coupling element (**12**), a transmission rod (**16**) axially movable within the guide casing, a feeler (**17**) eccentrically fixed to an end of said transmission rod for contacting the crankpin (**18**), a measurement transducer (**41**) fixed to the guide casing and provided with a movable element (**42**) cooperating with the other end of the transmission rod, and a device (**46**) for preventing rotational displacements of the transmission rod with respect to the guide casing.

18. An apparatus according to claims 8 and 17, wherein said device for preventing rotational displacements of the transmission rod (**16**) with respect to

the guide casing (**15**) comprises a metal bellows (**46**) having its ends fixed to the transmission rod and to the guide casing, respectively.

19. An apparatus according to claim 17 or claim 18 comprising two bushings (**44,45**) arranged between the guide casing (**15**) and the transmission rod (**16**), for centering and guiding the transmission rod with respect to the guide casing.

20. An apparatus according to claim 8, wherein said reference device (**20**) is fixed in a dismantable way to said guide casing (**15**).

21. An apparatus according to one of claims from 17 to 20, wherein said second coupling element comprises said guide casing (**15**) and an arm (**12**), substantially perpendicular to the guide casing, coupled in a rotating way to the first coupling element (**9**).

SM/--

55

B095A 000469

TAV. I

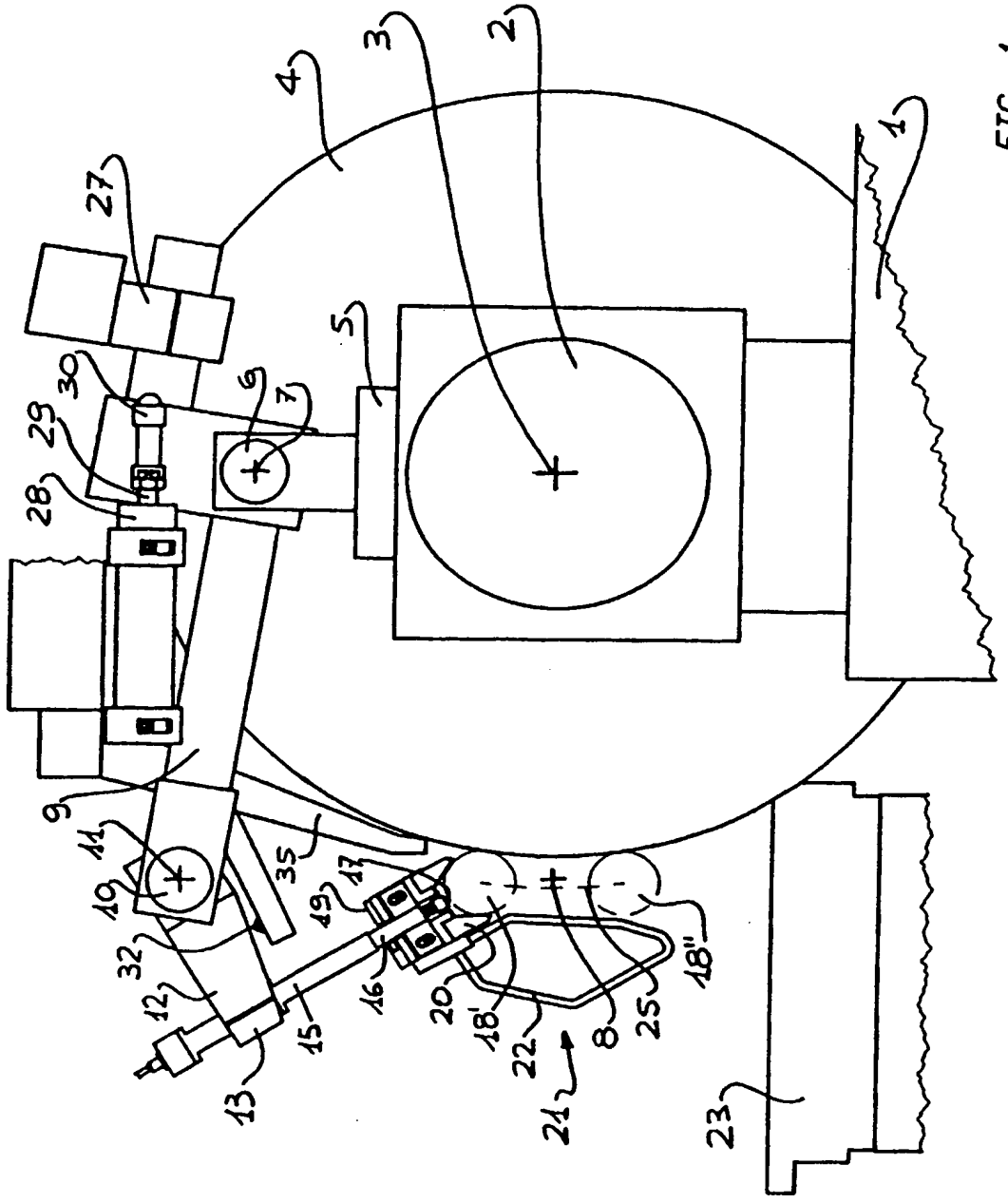

FIG. 1

UFFICIO PROVINCIALE INDUSTRIA COMMERCIO E ARTIGIANATO DI BOLOGNA
UFFICIO BREVETTI
IL FUNZIONARIO

MARPOSS
SOCIETA' PER AZIONI

B095A000469 TAV. II

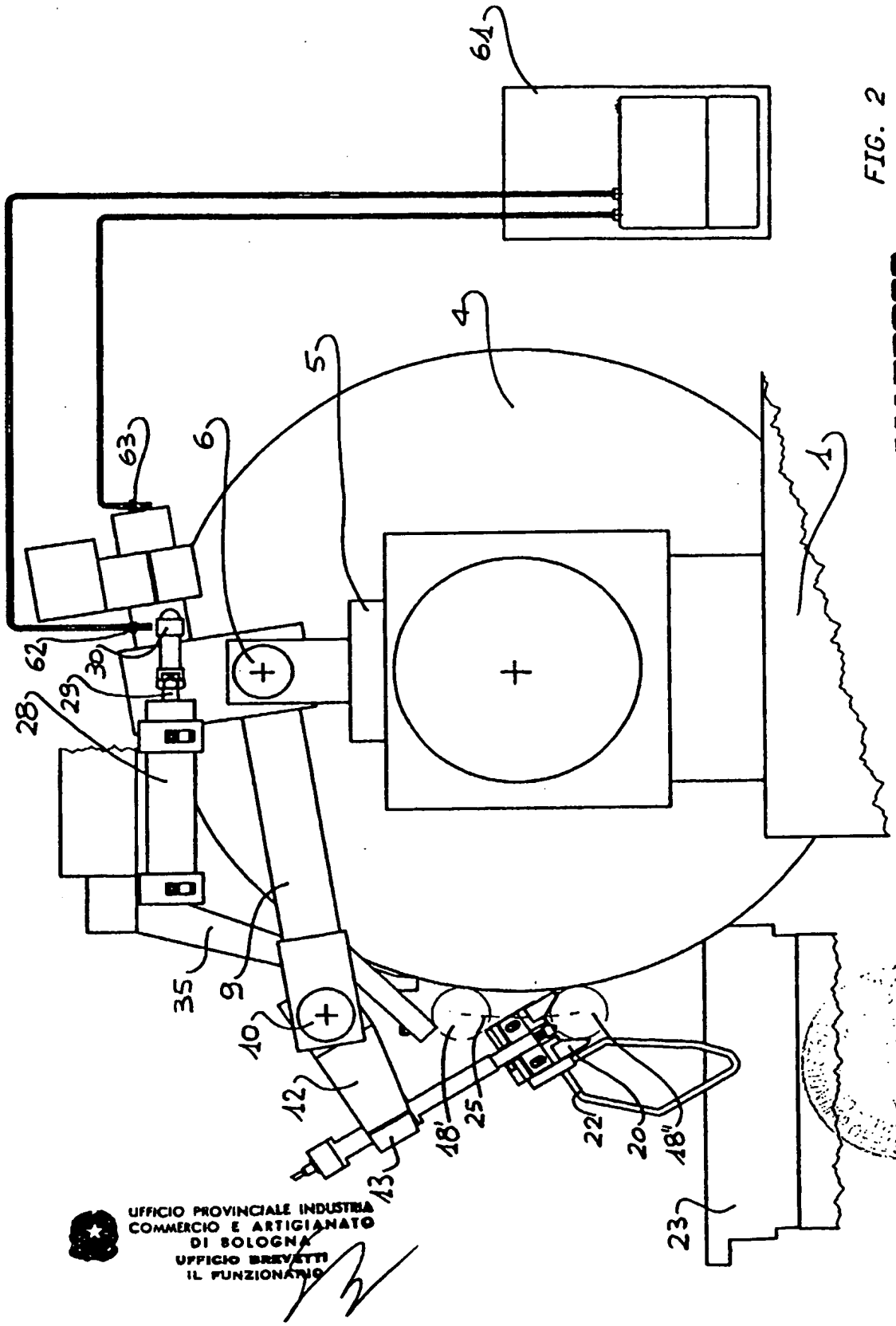

FIG. 2

MARPOSS
SOCIETA' PER AZIONI

UFFICIO PROVINCIALE INDUSTRIA
COMMERCIO E ARTIGIANATO
DI BOLOGNA
UFFICIO BREVETTI
IL FUNZIONARIO

B095A 000469

TAV. III

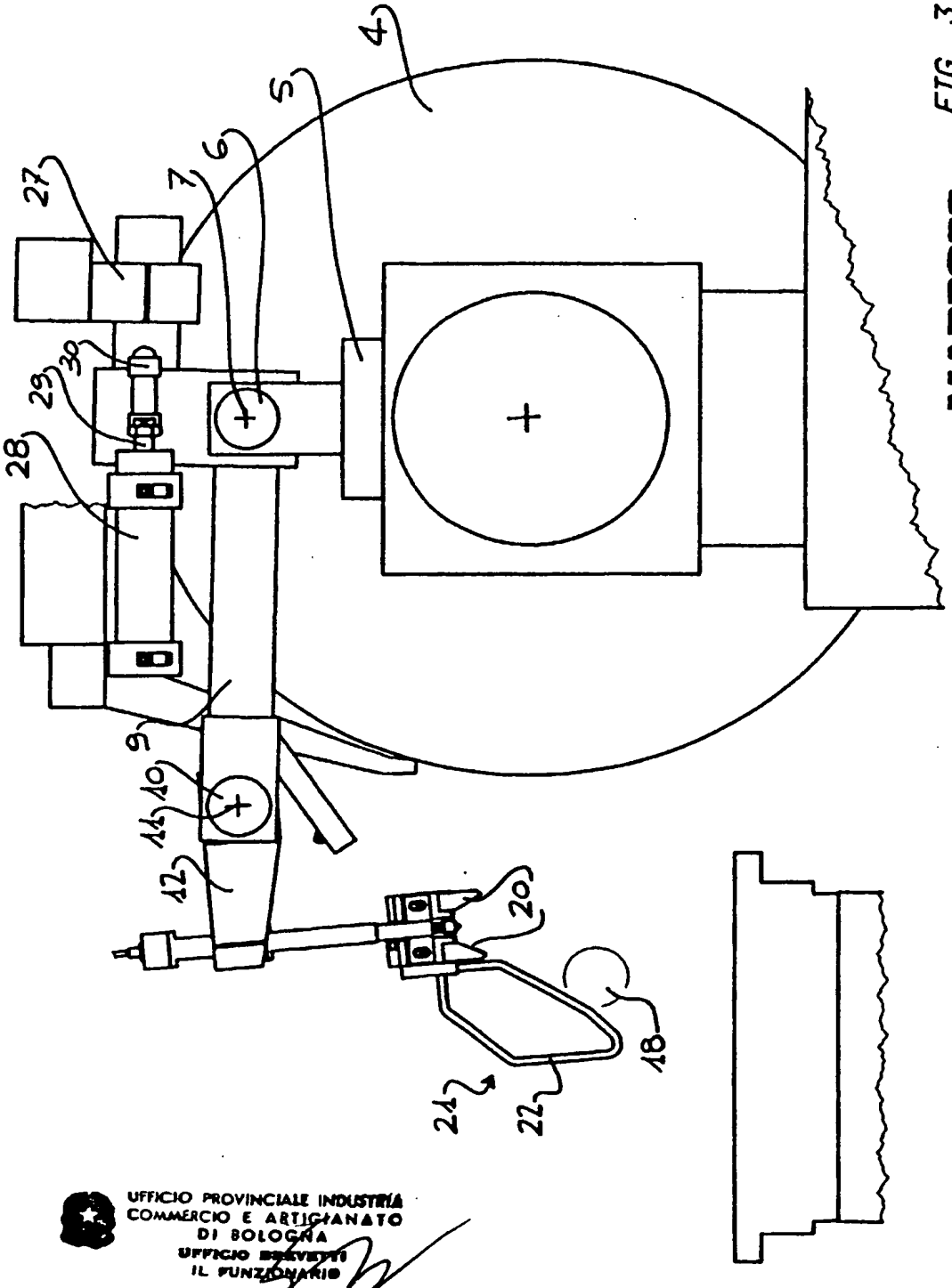

FIG. 3

MARPOSS
SOCIETA' PER AZIONI

UFFICIO PROVINCIALE INDUSTRIA
COMMERCIO E ARTIGIANATO
DI BOLOGNA
UFFICIO BREVETTI
IL FUNZIONARIO

B095A 000469 TAV. I V

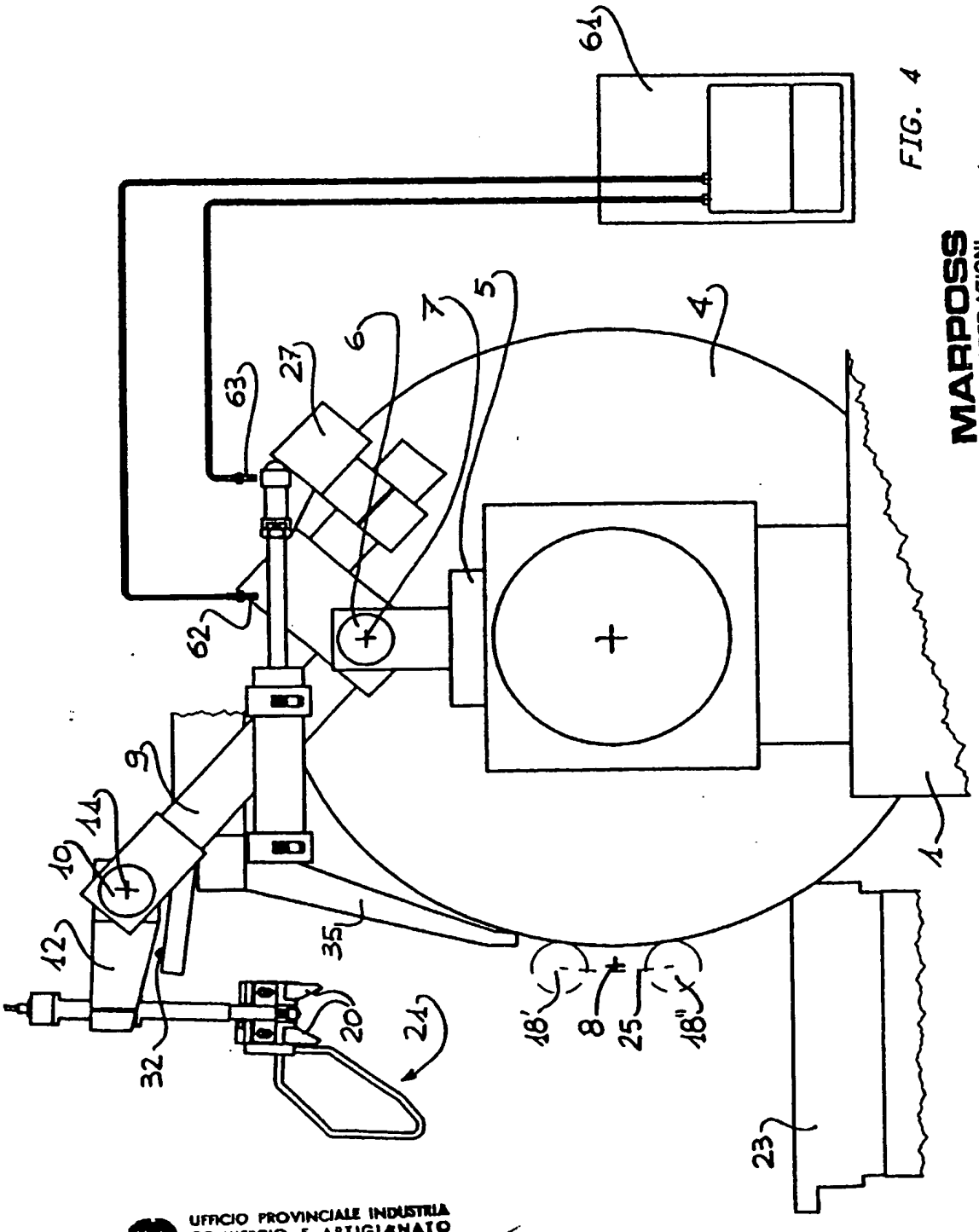

FIG. 4

MARPOSS
SOCIETA' PER AZIONI

UFFICIO PROVINCIALE INDUSTRIA
COMMERCIO E ARTIGIANATO
DI BOLOGNA
UFFICIO BREVETTI
IL FUNZIONARIO

B095A 000469

TAV. V

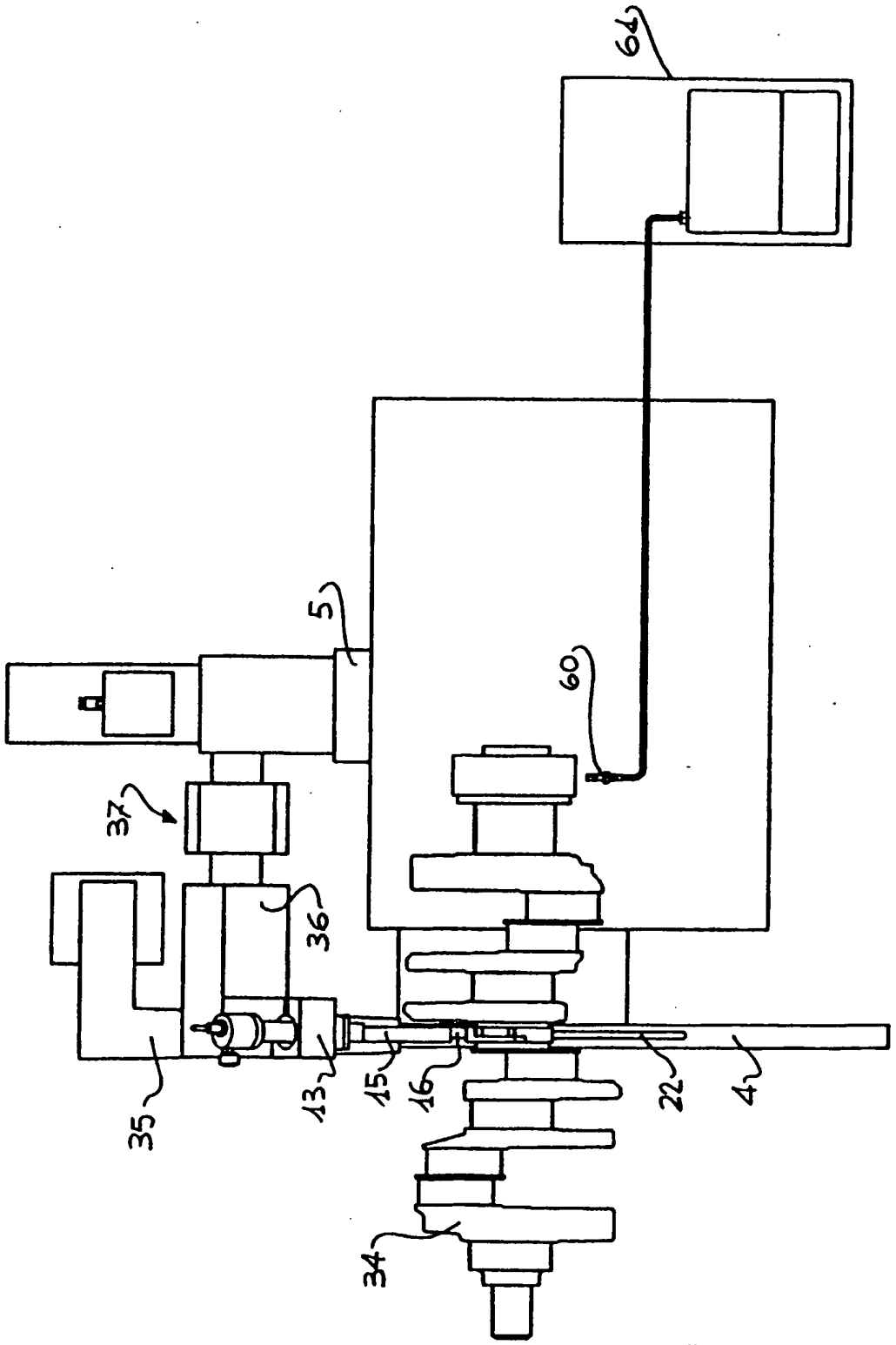

FIG. 5

UFFICIO PROVINCIALE INDUSTRIA
COMMERCIO E ARTIGIANATO
DI BOLOGNA
UFFICIO BREVETTI
IL FUNZIONARIO

MARPOSS
SOCIETA' PER AZIONI

B095A 000469 TAV. VI

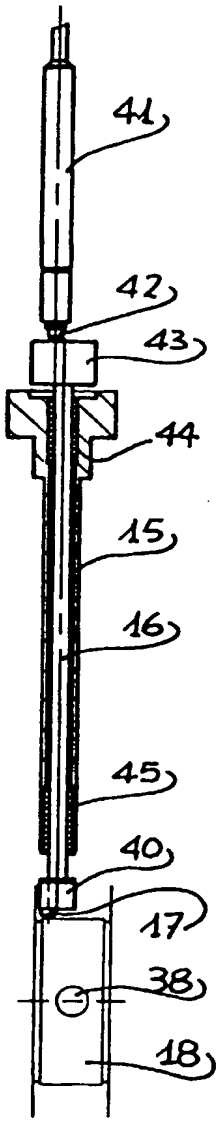

FIG. 6

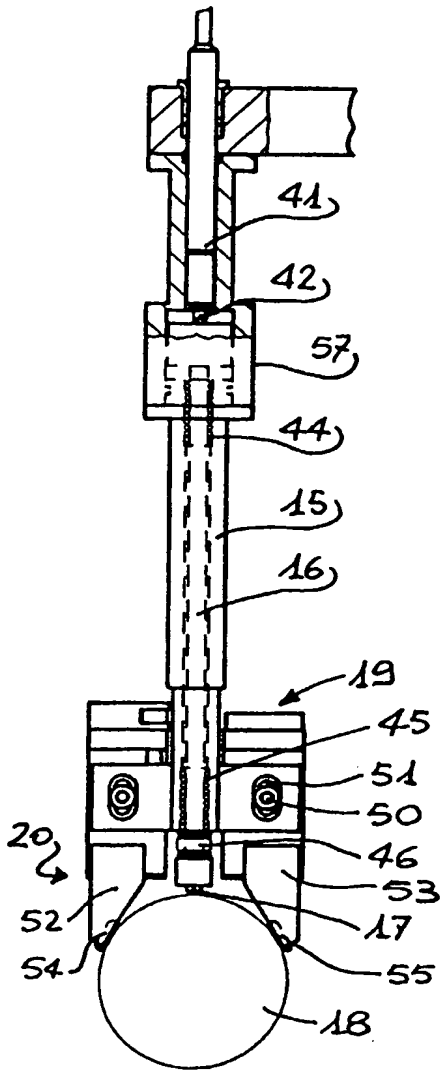

FIG. 7

MARCA DA BOLLO 5000 CINQUEMILA LIRE

MARCA DA BOLLO LIRE 15000

UFFICIO PROVINCIALE INDUSTRIA COMMERCIO E ARTIGIANATO DI BOLOGNA
UFFICIO BREVETTI
IL FUNZIONARIO

MARPOSS
SOCIETA' PER AZIONI